WE CLAIM:

1.   A network element (NE) of a data transport network
      across which a tunnel is provisioned, the NE
      comprising:

      a signal processor for maintaining a local occupancy
         status of a tunnel segment of the tunnel adjacent
         the NE, the signal processor adapted to use the
         local occupancy status and content of protection
         switch messages received from adjacent NEs of the
         tunnel to control use of data transport capacity
         over a link that locally supports the tunnel
         segment, and communicates the use of the data
         transport capacity to adjacent NEs of the tunnel,
         in protection switch messages; and

      a messaging system for exchanging the protection
         switch messages with adjacent NEs of the tunnel
         enabling distributed processing of the protection
         switch messages across the tunnel.

2.   The NE as claimed in claim 1 wherein the tunnel is a
      bidirectional tunnel, and the messaging system is a
      full-duplex messaging system that transmits the
      protection switch messages on two bidirectional
      links, if the NE is a tandem of the tunnel, and on
      one bidirectional link if the NE is an end point of
      the tunnel.

3.   The NE as claimed in claim 2 wherein the signal
      processor is further adapted to monitor each
      bidirectional link, and to relay a tunnel condition
      protection switch message in an opposite direction of

a detected link condition, if a link condition is detected at the NE, and the NE is a tandem.

4.   The NE as claimed in claim 3 wherein the messaging system comprises, for each of the bidirectional links, paired frame reception hardware and frame transmission hardware for processing consecutive frames of data transported over the bidirectional link, and the messaging system is provided by an automatic protection switch (APS) overhead of the frames that is presented to the signal processor with expedited interrupt-based handling.

5.   The NE as claimed in claim 4 wherein the signal processor is adapted to control the use of the data transport capacity by inserting pended and preempted indicators in the APS messages, which originate at end points of the tunnel.

6.   The NE as claimed in claim 5 wherein the signal processor is adapted to pend a received switch request if a current occupancy of one of the tunnel segments over which the switch request is transmitted is of an equal or higher priority than a request priority contained in the switch request.

7.   The NE as claimed in claim 5 wherein if the tunnel passing through the NE is transporting live traffic, and a request of a higher priority is received from another tunnel for the data transport capacity of one of the tunnel segments of the tunnel, the NE initiates a preemption of the tunnel by inserting the preempted indicator into the APS messages in both directions.

8.   A method for processing automatic protection switch
       (APS) messages at a network element (NE) in a tunnel
       provisioned across a data transport network, the
       method comprising:

       determining whether the NE is an end point of the
            tunnel, or a tandem of the tunnel, when a new APS
            message is received at the NE;

       if the NE is a tandem, applying a message handling
            procedure for the new APS message using local
            information about tunnel segments of the tunnel
            only maintained by the NE, to update the local
            information, and to selectively forward the
            updated information to adjacent NEs of the
            tunnel; and

       if the NE is an end point, updating a status of the
            tunnel.

9.   The method as claimed in claim 8 further comprising:

       receiving a notice of a link condition on a link of
            the NE supporting one of the tunnel segments,
            and, if the NE is a tandem of the tunnel,
            originating a tunnel condition message used to
            indicate the link condition to the tunnel end
            point, so that a protection switch may be
            initiated;

       receiving a tunnel status message from an adjacent NE
            in the tunnel from a K-byte overhead of a frame
            that serves as a data transport unit of the
            network; and

       receiving a message from a network management that
            prompts a protection switch, if the NE is an end
            point of the tunnel.

10.   The method as claimed in claim 9 wherein if the link
       condition is a signal degrade on a working tunnel,
       the   originating   the   tunnel   condition   further
       comprises:

       forwarding a tunnel condition message in the K-byte
            overhead to both adjacent NEs in the tunnel;

       waiting for a reply to the tunnel condition messages
            from the end points of the tunnel via the
            adjacent NEs; and

       receiving without forwarding the tunnel condition
            replies until the signal degrade link condition
            ends.

11.   The method as claimed in claim 9 wherein receiving a
       tunnel status message from an adjacent NE comprises
       receiving one of the following:

       a   protection   switch   request   used   to   erect   a
            protection tunnel; and

       a cede message, or a preempt message used to release
            a protection tunnel.

12.   The method as claimed in claim 11 wherein applying
       the message handling procedure upon receipt of a
       protection switch request message, comprises:

       identifying an occupant priority of data transport
            capacity supporting the tunnel segments of the
            tunnel;

       comparing the occupant priority with a priority
            contained in the protection switch request to
            determine   whether   the   protection   switch   is
            locally allowable;

forwarding the protection switch request over the tunnel segment if the protection switch is locally allowable; and

forwarding a pended protection switch request over the tunnel segment if the protection switch is locally not allowable

13. The method as claimed in claim 12 wherein comparing the occupant priority with the protection switch request priority comprises:

deeming the protection switch request allowed if the data transport capacity is unoccupied, and the occupant priority is consequently null;

deeming the protection switch request allowable if the occupant priority is less than the protection switch request priority; and

deeming the protection switch request not allowable if the occupant priority is greater than or equal to the protection switch request priority.

14. The method as claimed in claim 13 wherein the tunnel is a bidirectional tunnel, and the receiving the protection switch request comprises receiving the protection switch request from an adjacent NE in a first direction of the tunnel, removing any occupant, and building the cross-connect if the protection switch request is allowable, and an unpended switch request is received from the tunnel, in a direction opposite the first direction.

15. The method as claimed in claim 14 further comprising building the cross-connect as soon as the switch

request is deemed allowed, and if the switch request received from the opposite direction is pended, taking down the cross-connect.

16.   A method for processing a protection switch request at a network element (NE) in a tunnel provisioned across a data transport network, the method comprising:

receiving the protection switch request, and determining whether the NE is an end point of the tunnel, or a tandem of the tunnel; and

if the NE is a tandem, using an occupancy status of a tunnel segment of the tunnel only maintained by the NE, and a priority of the protection switch request to determine whether the protection switch is locally allowable; forwarding the protection switch request over the tunnel segment if the protection switch is locally allowable; and forwarding a pended protection switch request over the tunnel segment if the protection switch is locally not allowable.

17.   The method as claimed in claim 16 further comprising maintaining the occupancy status by storing information related to whether data transport capacity that supports tunnel segments of the tunnel is idle, or a tunnel segment of an occupant tunnel is switch connected to another tunnel segment, and uses the data transport capacity; an occupant priority of the occupant tunnel; a link condition of a link providing the data transport capacity; and whether the NE is preempting the occupant tunnel, or pending the protection switch request.

18.   The method as claimed in claim 17 wherein the determining whether the protection switch request is locally allowable comprises:

comparing the priority contained in the protection switch request with the occupant priority;

deeming the protection switch request allowed if the data transport capacity is unoccupied;

deeming the protection switch request allowable if the occupant priority is less than the protection switch request priority; and

deeming the protection switch request not allowable if the occupant priority is greater than or equal to the protection switch request priority.

19.   The method as claimed in claim 18 wherein the tunnel is a bidirectional tunnel, and the receiving the protection switch request message comprises receiving the protection switch request from an adjacent NE in a first direction of the tunnel, preempting the current occupant, and building the cross-connect if the protection switch request is allowable, and an unpended switch request is received from the tunnel, in a direction opposite the first direction.

20.   The method as claimed in claim 19 further comprising building the cross-connect as soon as the switch request is deemed allowed, and if the switch request received from the opposite direction is pended, taking down the cross-connect.